Appendix K – ADM CCS#1 Descriptive Report Geophysical Logs

Appendix K

ADM CCS #1

Geophysical Log Descriptive Report

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The Logging Program

The table below identifies the logging runs made by date and depth, the tools included in each run, and the primary reason for running that logging tool.

Logging Tools by Run

Date / Depth	Logging Run	Logging tools	Data Used For:
March 9, 2009 352 - 3541 ft	**PEX-AIT (Platform Express)**	GR, Caliper, SP, Resistivity (Induction), Density, Neutron	Correlation, Porosity, Saturations, Hole Size
April 5, 2009 352 – 5317 ft	**PEX-AIT (Platform Express)**	GR, Caliper, SP, Resistivity (Induction), Density, Neutron	Correlation, Porosity, Saturations, Hole Size
	HRLA	Resistivity (Laterolog)	Resistivity - Saturation
	SonicScanner, FMI	Sonic compressional and shear, Formation Micro-Imager borehole images	Porosity, Mechanical Properties, Structure, Env. Deposition, Fractures
	CMR, ECS, HNGS	Magnetic Resonance, Elemental Capture Spectroscopy, Spectral GR	Lithology, Clay Minerals, Porosity, free and bound fluids, Permeability
	MSCT	Sidewall Coring Tool	Porosity, Permeability
April 26, 2009 5339 – 7221 ft	**PEX-HRLA (Platform Express)**	GR, Caliper, SP, Resistivity (Laterolog), Density, Neutron	Correlation, Porosity, Saturations, Hole Size
	Sonic Scanner, FMI	Sonic compressional and shear, Formation Micro-Imager borehole images	Porosity, Mechanical Properties, Structure, Env. Deposition, Fractures
	CMR, ECS, HNGS	Magnetic Resonance, Elemental Capture Spectroscopy, Spectral GR	Lithology, Clay Minerals, Porosity, free and bound fluids, Permeability
	MSCT	Sidewall Coring Tool	Porosity, Permeability
	MDT	Modular Dynamic Tester	Formation Pressure, Mobility
	VSIT	Versatile Seismic Imager	Tie logs to seismic

In summary the standard “Triple Combo” data of the Platform Express (PEX) run includes GR, Caliper, Resistivity, Density, and Neutron measurements and is run for basic petrophysical properties of volume of shale, basic lithology, porosity and saturations. The Gamma Ray and Resistivity are also the primary measurements used for correlation to other wells. Either an induction tool or laterolog tool are used to measure the formation resistivity depending on the conductivity of the mud system in the borehole and

the conductivity of the formation water. The Elemental Capture Spectroscopy (ECS) is used to identify lithology type by measuring elemental yields and to improve the clay volume calculation. The HNGS provides natural gamma ray spectroscopy to aid in the analysis of the different clay types and special minerals containing potassium. The Combinable Magnetic Resonance (CMR) manipulates the nuclei of hydrogen atoms buy applying a strong magnetic field and RF pulses. The tool then measures the response of the nuclei to the changing magnetic field, with the resulting measurement is the T2 distribution. From this measurement porosity is derived and this porosity can be subdivided based on the T2 measurement to provide information on the pore size distribution, and what portion of the fluid in the porosity is bound fluid and what is free fluid. This measurement is also used to calculate a continuous permeability based on porosity and the pore size distribution. The Sonic Scanner tool is an array sonic tool used to measure the compressional and shear sonic velocities in the formation. These measurements can then be used to calculate sonic porosity and Mechanical Rock Properties. The FMI is used to identify structure, depositional environment and fractures that may be present in the formations. The Mechanical Sidewall Coring Tool (MSCT) will take multiple rotary sidewall cores and return them to surface for analysis. The Modular formation Dynamics Tester (MDT) can take multiple pressures and fluid samples depending on its configuration. The Versatile Seismic Imager (VSIT) data aids in the tie between the seismic data and the log data.

General Interpretation of the data

The interpretation of the data is done using the ELAN-Plus computer program within GeoFrame. The Elemental Log ANalysis (ELAN) evaluation is done by optimizing simultaneous equations described by one or more interpretation models. The resulting analysis provides key petrophysical answers that describe the reservoir. Answers derived from this analysis include but are not limited to porosity, lithology, and permeability. Following is a brief description of the data provided on the ELAN analysis presentation.

Depth Track

GR – Gamma Ray

Caliper – Hole Size

RSOZ – Resistivity Standoff, Quality control indicating enlarged borehole.

DSOZ – Density Standoff, Quality control indicating enlarged borehole.

Bad Hole Flag - Quality control indicator, hole is too large or rugose for a measurement to be made.

Track 1

RLA5 to RLA2 – Array laterolog resistivity measurements with different depth of investigation. RLA5 is the deepest depth of investigation

RXO_HRLT – Laterolog resistivity measurement with shallow depth of investigation indicating the resistivity of the invaded zone.

Track 2

PEFZ – Photoelectric Effect. This is used for lithology identification.

RHOZ – Measurement of the bulk density of the formation. This is used in combination with the neutron and sonic for lithology identification as well as identification of fluids in the porosity.

Neutron - Measurement of the neutron porosity (lime) of the formation. This is used in combination with the density and sonic for lithology identification as well as identification of fluids in the porosity.

Density Correction – Correction applied to the density measurement for borehole affects such as mudcake.

DTCO – Delta T, sonic travel time of the compressional mode from the Sonic Scanner

Track 3

Kint ELAN – Permeability derived from the ELAN analysis. Core data presented if available.

Track 4

Porosity – Effective porosity as calculated by ELAN. This analysis also includes the vuggy porosity identified in the carbonates. Core data presented if available.

Track 5

Volumetric display of lithology and fluids solved for in ELAN. Core data presented if available.

Detailed Interpretation of the Injection Zone (Mount Simon)

The injection zone in the ADM CCS #1 well is the Mount Simon Formation which extends from the base of the Eau Claire Shale at 5544 ft to the top of the Granite Wash zone at 7049 ft. The petrophysical model used to evaluate the Mount Simon Formation included all minerals identified to be present in significant quantities in the cores that were analyzed for lithology. Though the Mount Simon is considered to be a clean sand, the major reservoir type rocks of limestone and dolomite were also included in the model. The clays used in the model were illite, chlorite, and kaolinite. Also included in the analysis is orthoclase due to the significant amount of potassium feldspar minerals found in the cores. Water was the only fluid included in the formation model, but the T2 pore size distribution measurement from the CMR tool was used to differentiate the free fluids from the bound fluids.

The results of the analysis indicate that the Mount Simon can be thought of as three separate units primarily based on the pore volume and pore size distribution. The bottom interval in the Mount Simon contains the highest average porosity and quite good permeability. This interval extends from the base up to 6420 ft. The section of the Mount Simon from 6420 ft to approximately 5950 ft is relatively low porosity with significantly reduced permeability. The third interval of the Mount Simon is from approximately 5950 ft to the top of the Mount Simon at 5544 ft. While the lithology does not vary significantly and is dominated by sand (quartz), there can be up to 15% clay and 25% orthoclase.

The bottom interval in the Mount Simon is the primary injection zone and has an average porosity of 16.8%, but there are intervals where the porosity approaches 30%. Average permeability in this interval is 33 md; however, permeability in the perforated interval ranges from 60 md to several hundred md.

There are a few thin shale intervals within the bottom section of the Mount Simon however, correlating this interval in the CCS #1 well with the Verification Well #1 it is thought that these shale intervals are more likely to act as baffles rather than barriers to the movement of injected CO_2 as they do not appear to be continuous.

The middle interval of the Mount Simon has an average porosity of 9% and an average permeability of only 2.5 md. Based on the CMR pore size distribution and measurement of bound fluids, most of the fluids in this interval appear to be bound fluids, hence the greatly reduced permeability. While this interval is not considered to be a seal to the movement of CO_2, it will significantly retard the upward movement of CO_2.

The top interval of the Mount Simon has an average porosity of 10.6% and an average permeability of 66 md. The permeability increase in this interval is due to the measurement of the pore size distribution indicating that in this interval, while having lower total pore volume than the bottom interval the pores are larger therefore permeability is greater.

Detailed Interpretation of the Primary Seal (Eau Claire Shale)

The Eau Claire Shale will act as the primary seal for injected CO_2 into the Mount Simon. The Eau Claire Shale is 317 feet thick and covers the interval from 5227 ft to 5544 ft. The clays identified from the analysis include primarily illite and chlorite, with just a small amount of kaolinite. Based on the analysis of the CMR data the pore sizes in the Eau Claire are quite small and the resulting permeability is therefore very low. There are only a few small intervals of less than a few feet that have any permeability greater than 0.1 mD and these do not appear to be continuous. The Eau Claire Shale should provide a good seal for CO_2 injected into the Mount Simon.

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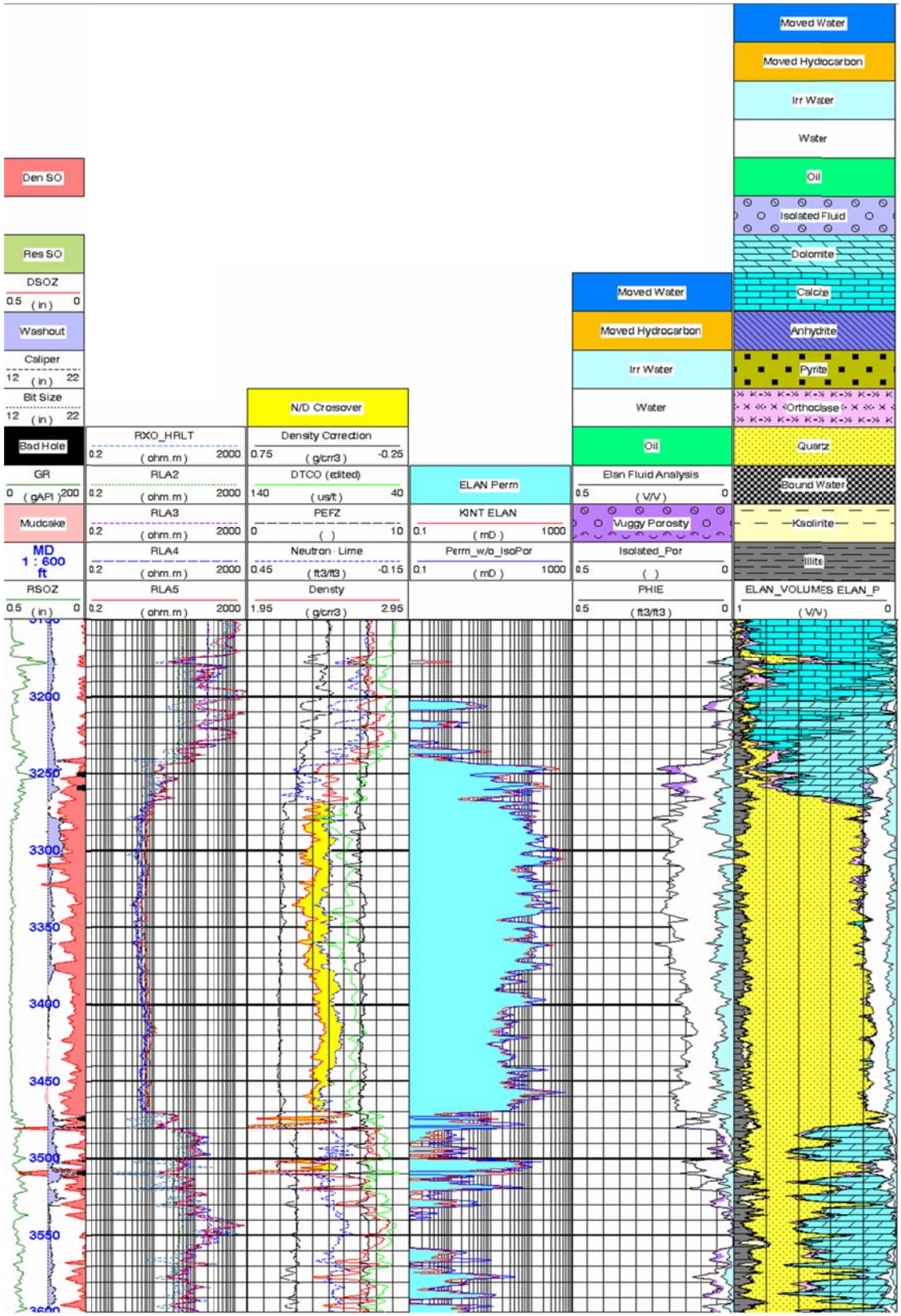
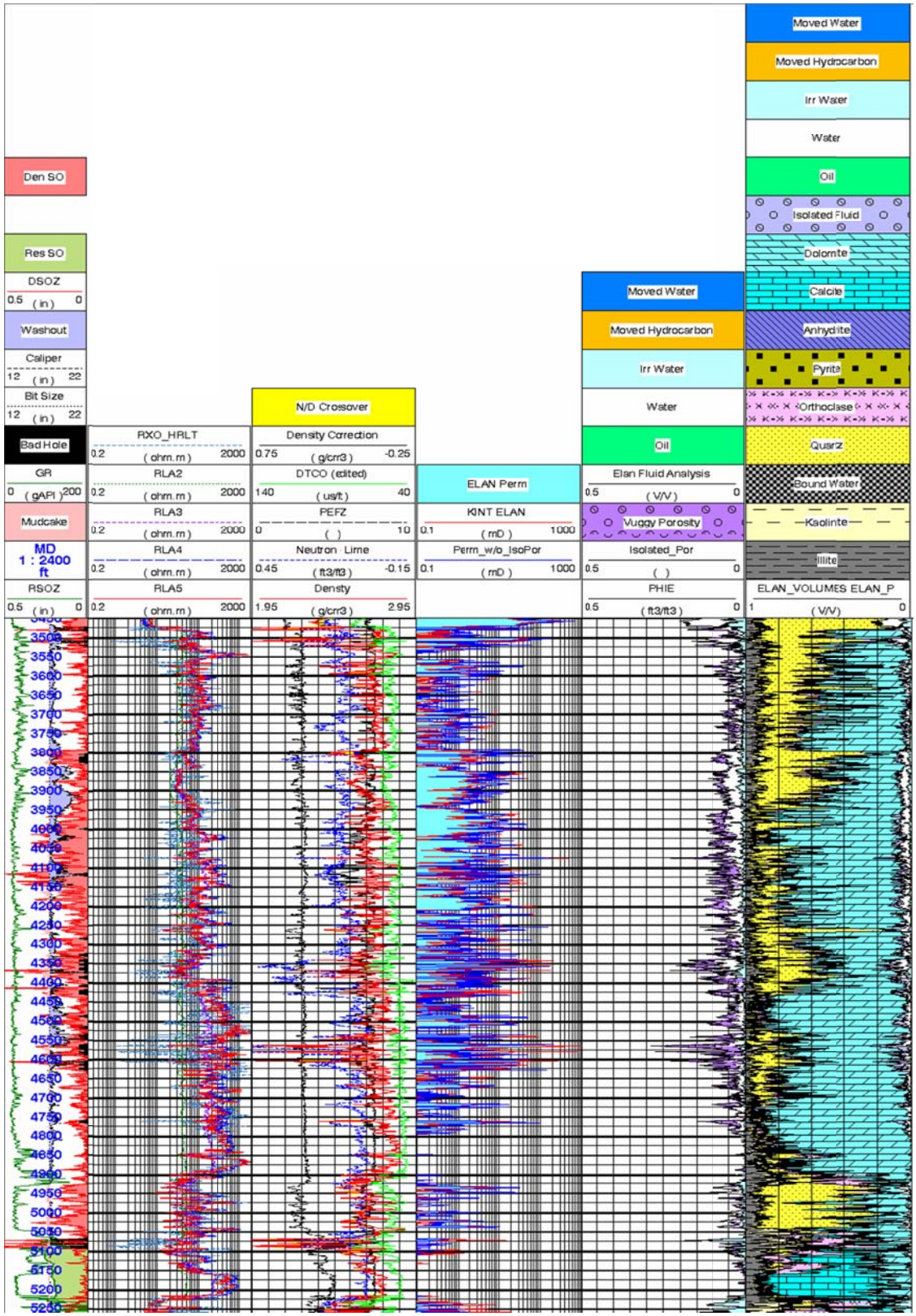
ELAN of St. Peter – CCS #1



ELAN of Knox – CCS #1



ELAN of Mt. Simon – CCS #1